



# **Mercury dynamics in Stormwater Drain System PSNS015**

**Preliminary Results from USGS Investigations  
December 2011 – June 2012**

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# Recent USGS/US Navy Program

- 2007-2012 activities include:
  - Synthesis of existing data
  - Methylmercury survey
    - Methylation in sediments
    - Release and Bioaccumulation
  - Sources and Sinks survey
    - Well LTMP-3 submarine discharge
    - Dry dock solids
    - Steam plant conversion
    - Creeks, wet weather
    - LTMP-5 and MW-709 submarine discharge
    - **Tidal flushing of PSNS015**



Prepared in cooperation with the Department of the Navy  
Naval Facilities Engineering Command, Northwest

**Sources and Sinks of Filtered Total Mercury and  
Concentrations of Total Mercury of Solids and of Filtered  
Methylmercury, Sinclair Inlet, Kitsap County, Washington,  
2007–10**

Scientific Investigations Report 2012–5223

U.S. Department of the Interior  
U.S. Geological Survey

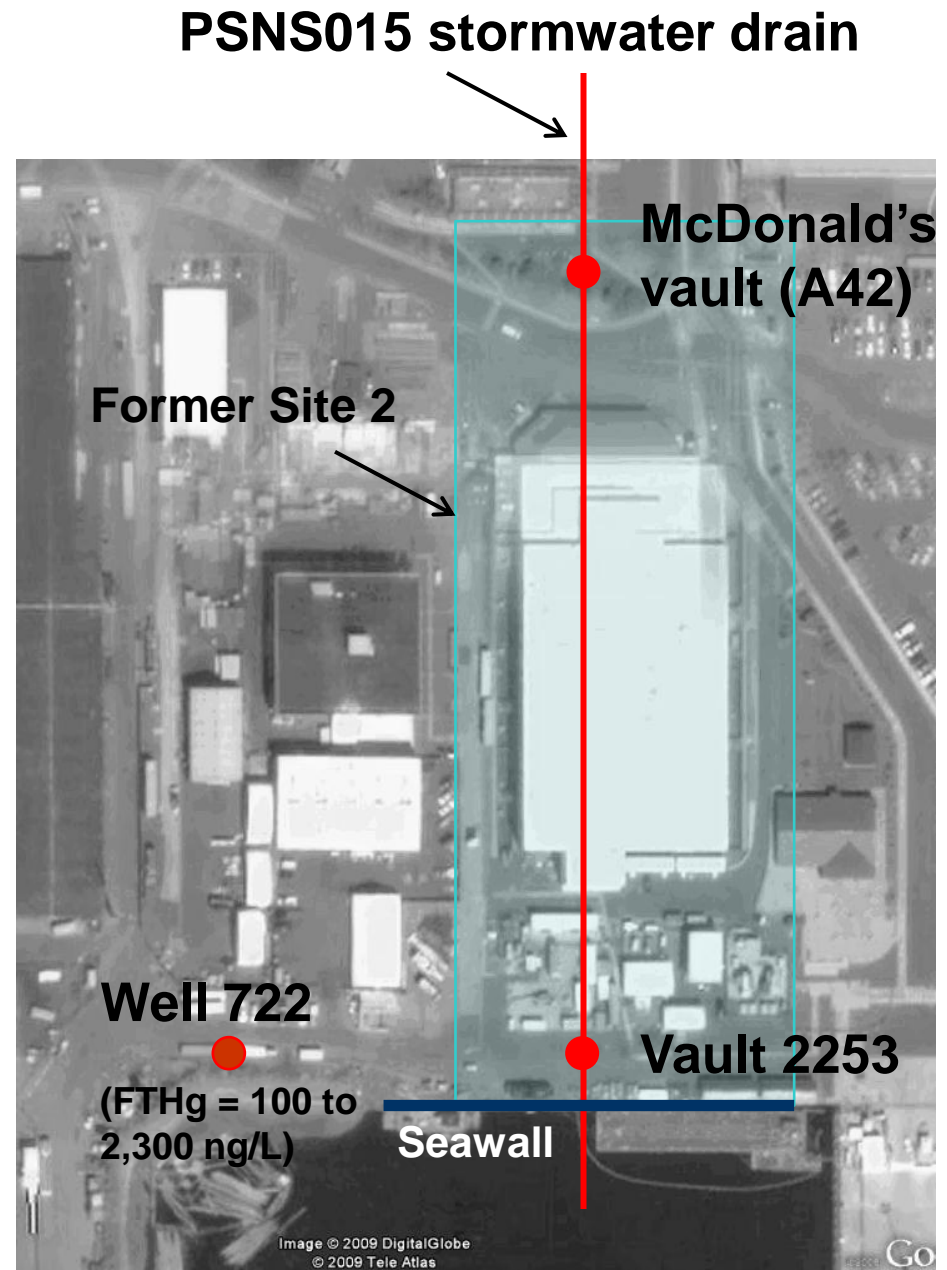
# Background

- Former Site 2 – soils contaminated with PCBs, mercury, lead
- PSNS015 is a conduit for inland seawater movement during high tides

## *Definitions:*

THg = total mercury (all chemical forms)

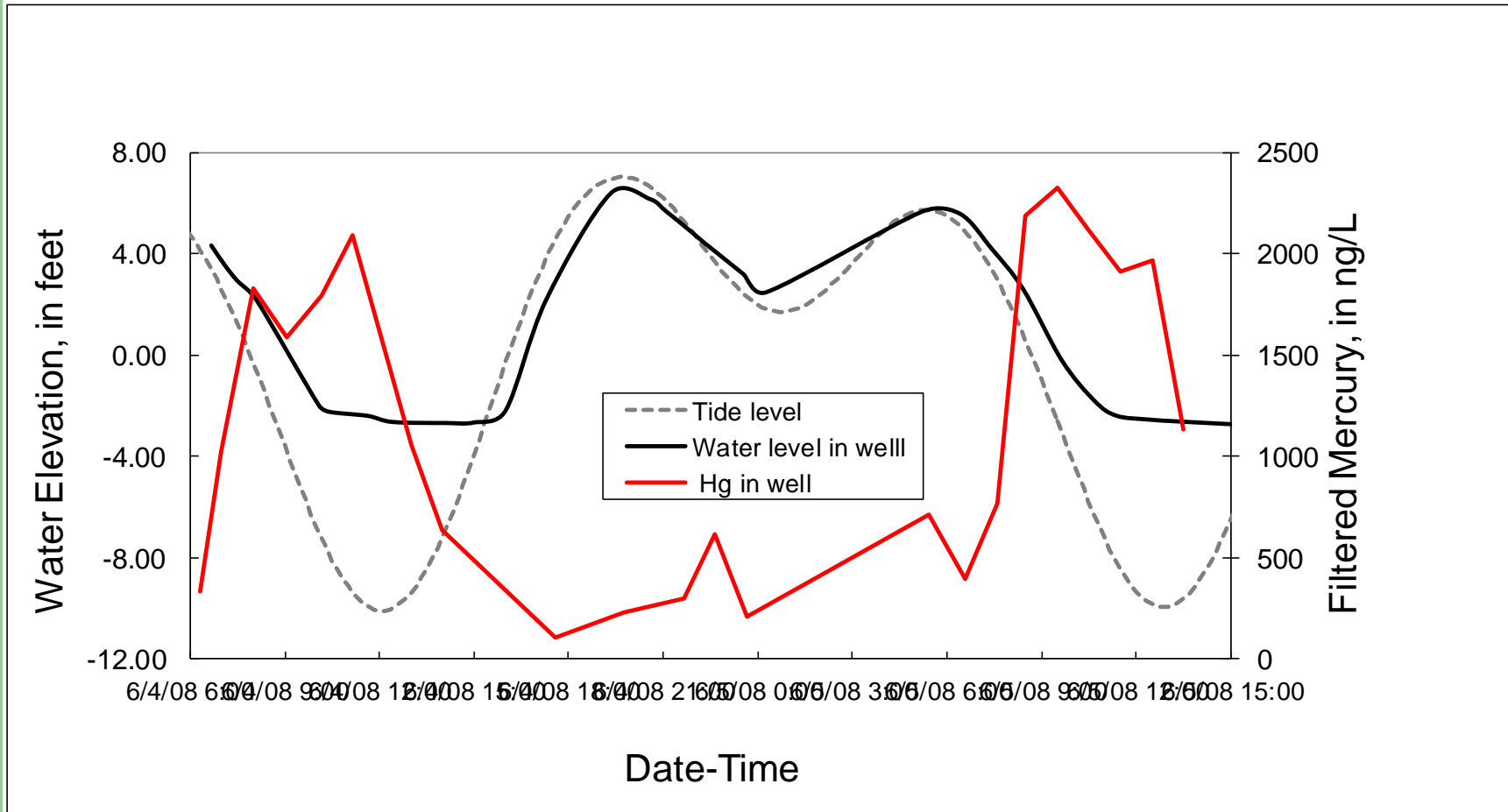
WTHg (unfiltered total mercury) =  
FTHg (filtered total mercury) +  
PTHg (particulate total mercury)



*Preliminary results, subject to revision*

# Background

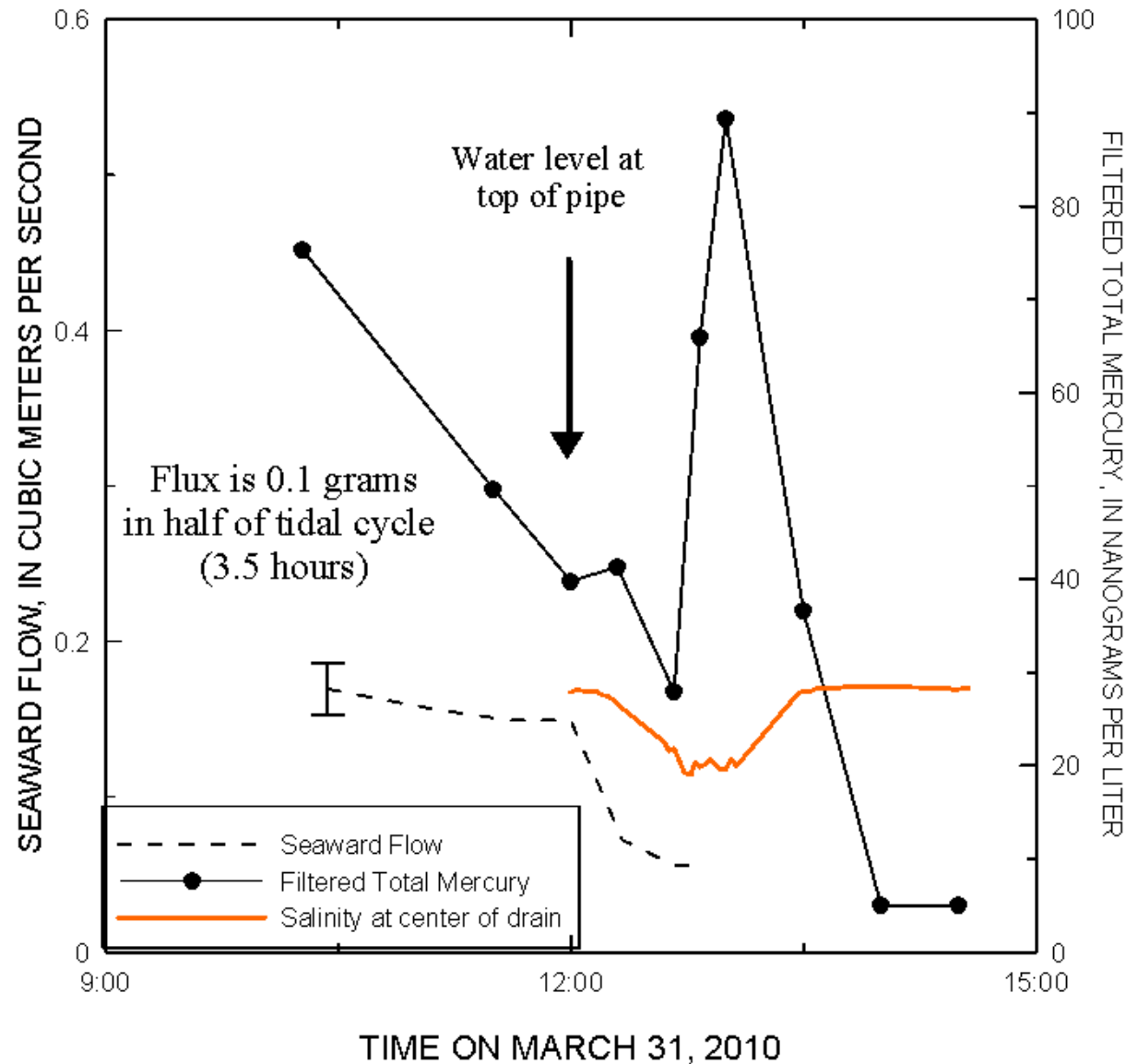
- Well 722 - FTHg increased in groundwater during ebbing tides



*Preliminary results, subject to revision*

# Background

- In McDonalds vault, FTHg = 144 ng/L in freshwater (1/9/2009)
- In vault 2253, 730 g Hg/yr = estimated Hg loading from tidal flushing through PSNS015 stormwater drain system



*Preliminary results, subject to revision*

# Objectives

- Determine inland extent of seawater intrusion within PSNS015 stormwater drain system
- Identify potential sources of mercury in freshwater to McDonalds vault
- Characterize tidally-influenced concentrations of Hg and ancillary data in McDonalds vault during a spring tide
  - Repeat tidal study during a neap tide

# Extent of Seawater Intrusion

- Approach: Collect Cond/Temp/Depth (CTD) profiles at 6 vaults at high tide



## Sampling locations:

Commissary (F/30-8\*)

Sidewalk (H-30/1)

Gym (J/30-2)

Intersection (K/30-1)

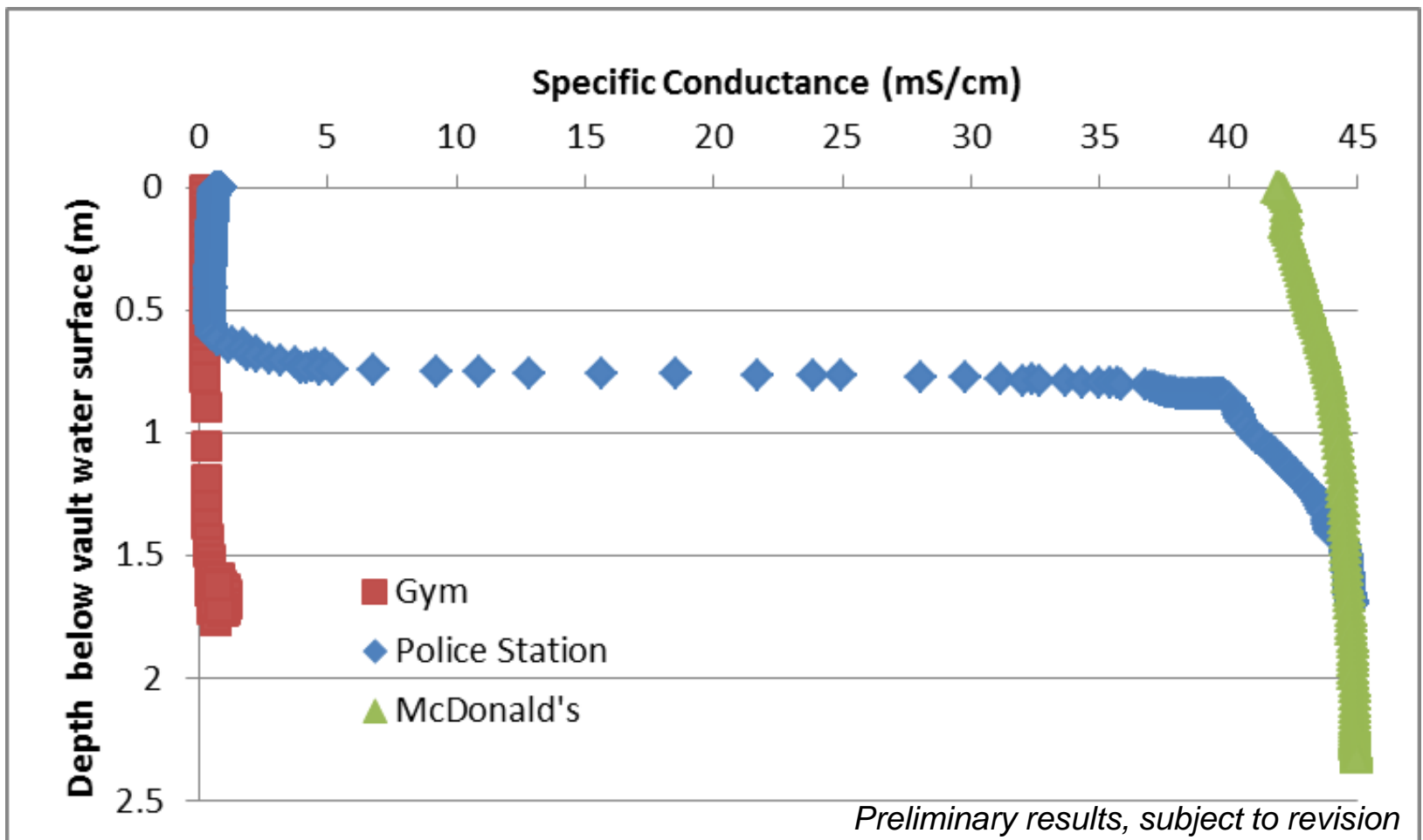
Police Station (M/30-9)

McDonald's (A42)

\*From PDF C1-57837

# Extent of Seawater Intrusion

- Freshwater/Saltwater stratification occurs between police station and gym



# Identify freshwater sources of Hg

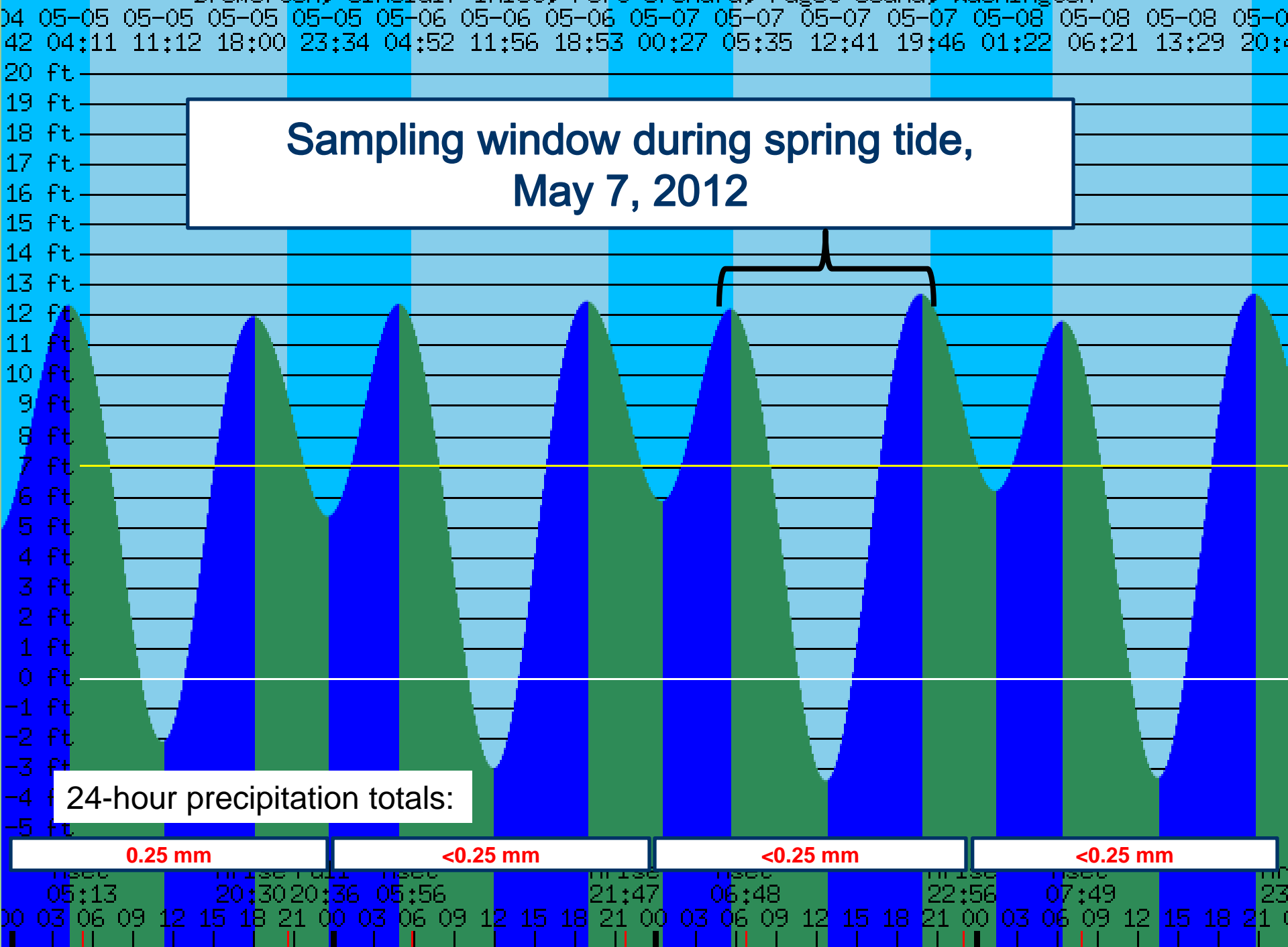
- Approach - Collect water samples from 6 vaults and inverts (22 unique locations) during ebbing tide
  - Analytes
    - Filtered total mercury (FTHg)
    - Particulate total mercury (PTHg)
    - Total suspended solids (TSS)
    - specific conductance
    - pH, alkalinity, major ions
- All 22 samples
  - Freshwater (Specific Conductance < 300  $\mu\text{S}/\text{cm}$ )
  - Low mercury (FTHg < 10 ng/L)

# Identify freshwater sources of Hg

- Difference between January 2009 (144 ng/L) and December 2011 (<10 ng/L):
  - Precipitation and recharge
    - 2011 – 2X precipitation before and during sampling
  - Neap versus Spring Tides
    - 2009 – Spring tide (13' difference)
- New Hypothesis:
  - Mercury contamination in PSNS015 is from contaminated soils at former Site 2 (seaward of McDonalds vault)
  - Retention of freshwater during neap tides
  - Complete flushing of storm drain during spring tides

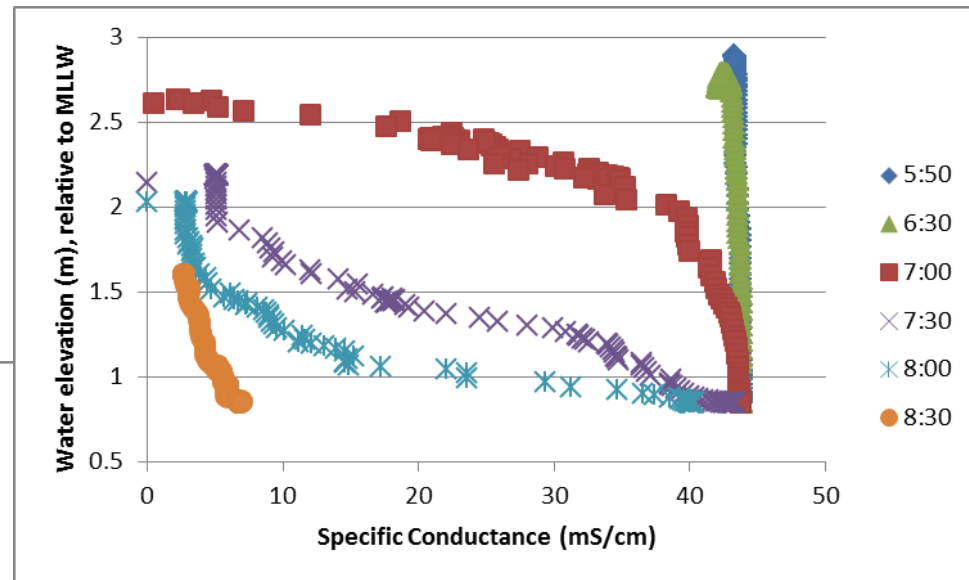
# Characterize tidally-influenced Hg concentrations in McDonalds vault

- Approach –
  - 2 tidal studies – spring tide and neap tide
  - 13-hour sampling study (lower high to higher high)
  - <0.1 inches of rainfall in previous 24 hours
  - 30-minute water level measurements
  - Surface and Bottom CTD profiles (also inland vaults)
  - 35 samples collected:
    - Hourly samples from bottom of vault
    - Other samples: water surface and inverts, upland vaults
    - Field and laboratory replicates
  - Analytes:
    - FTHg, PTHg, TSS, Sp. Cond.
    - pH, alkalinity, major ions
    - *E. coli* and total coliforms (qualitative, Spring) and fecal coliform (quantitative, Neap)



# Spring Tide (May 7, 2012)

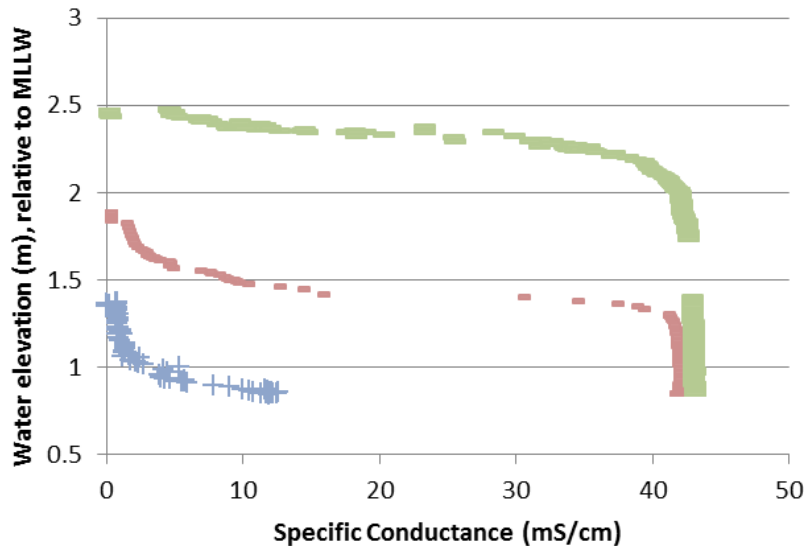
- CTDs in McDonalds vault
  - As water level dropped, saltwater moved out to Sinclair Inlet and freshwater lens remained



Ebbing tide

+ 16:30  
- 17:00  
- 18:00

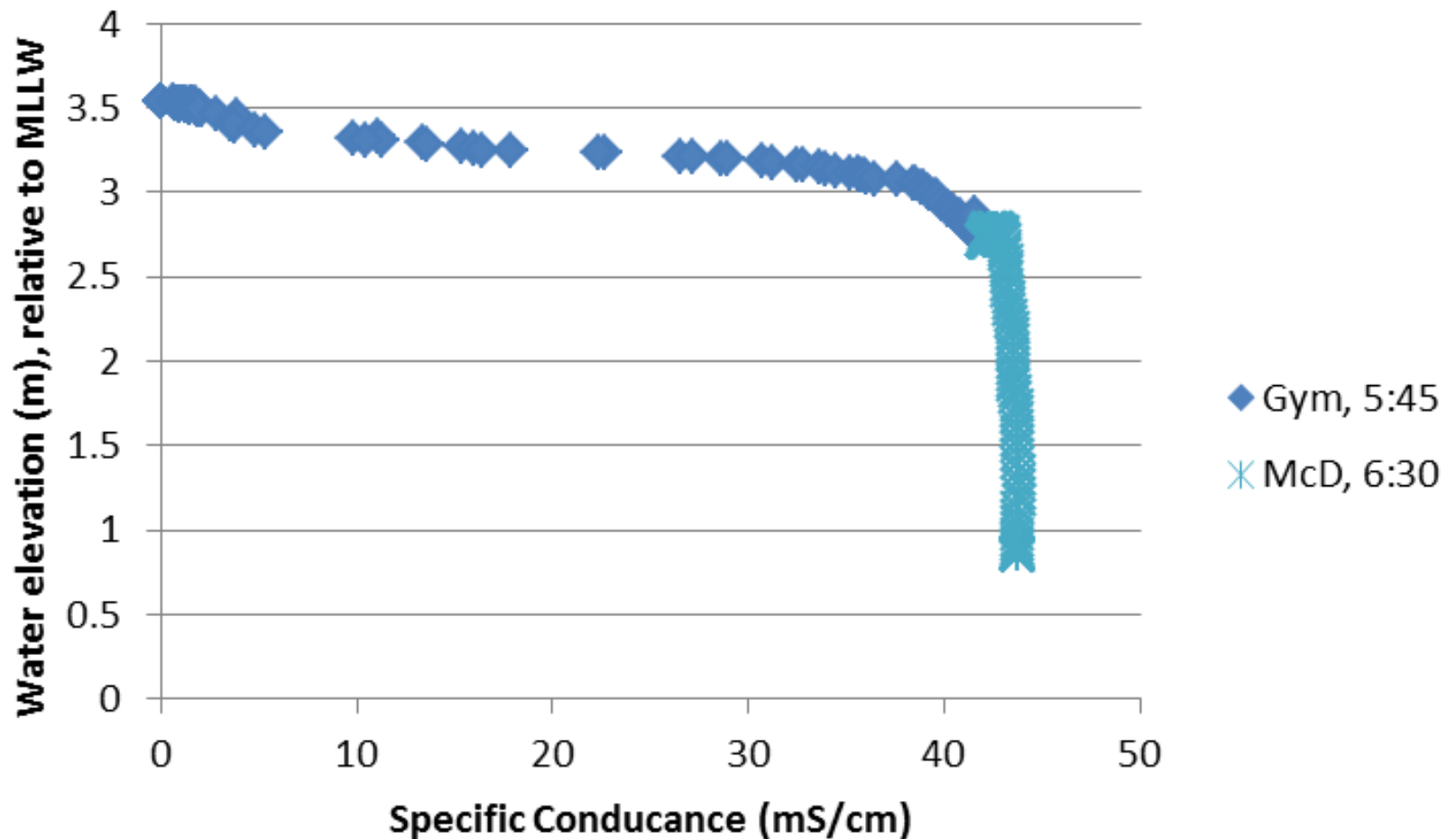
Flooding tide



*Preliminary results, subject to revision*

# Spring Tide (May 7, 2012)

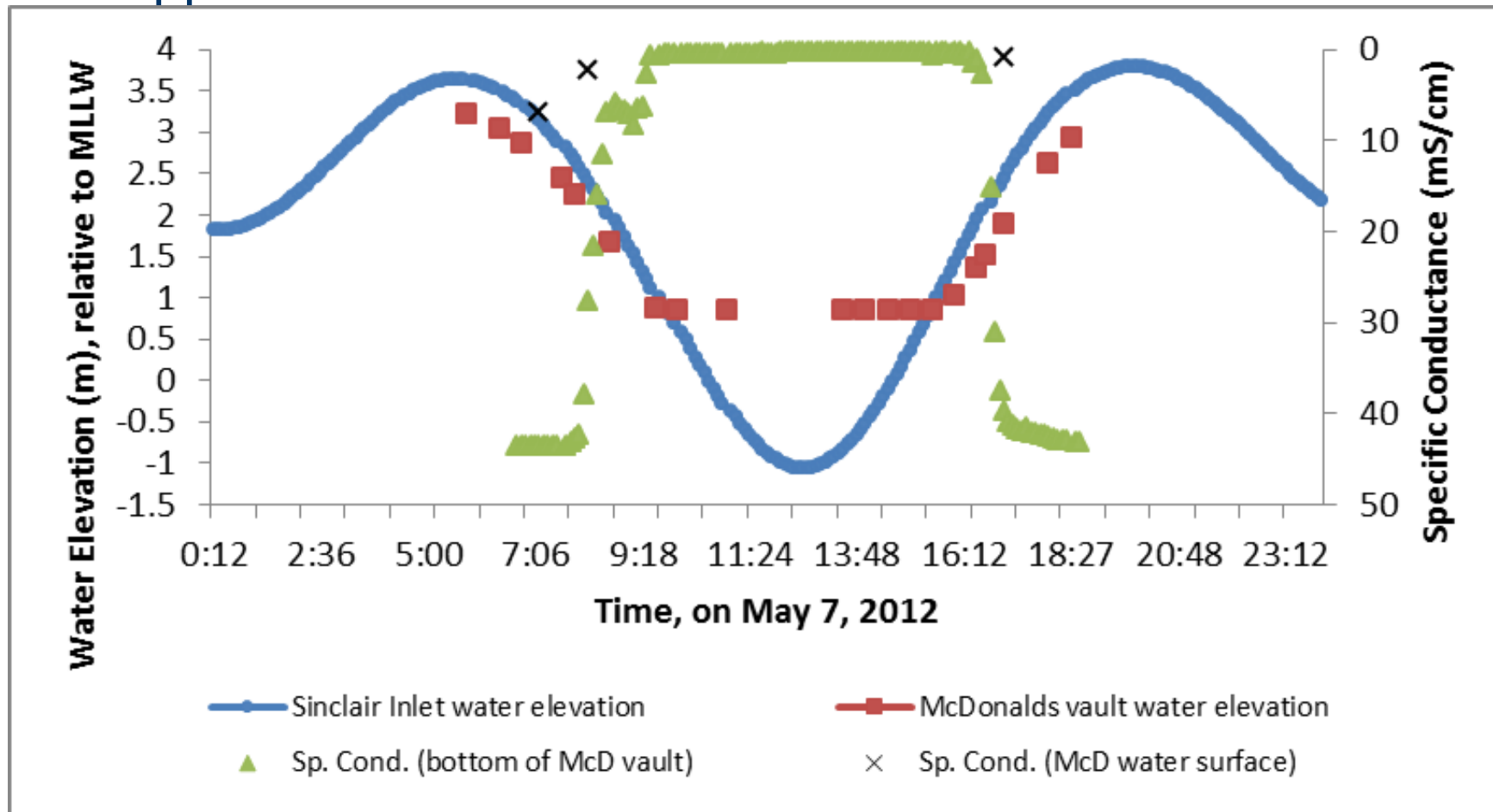
- During high tide, salt wedge extended to gym



*Preliminary results, subject to revision*

# Spring Tide (May 7, 2012)

- Water elevation – At 9:30, water level in Sinclair Inlet dropped below vault water level

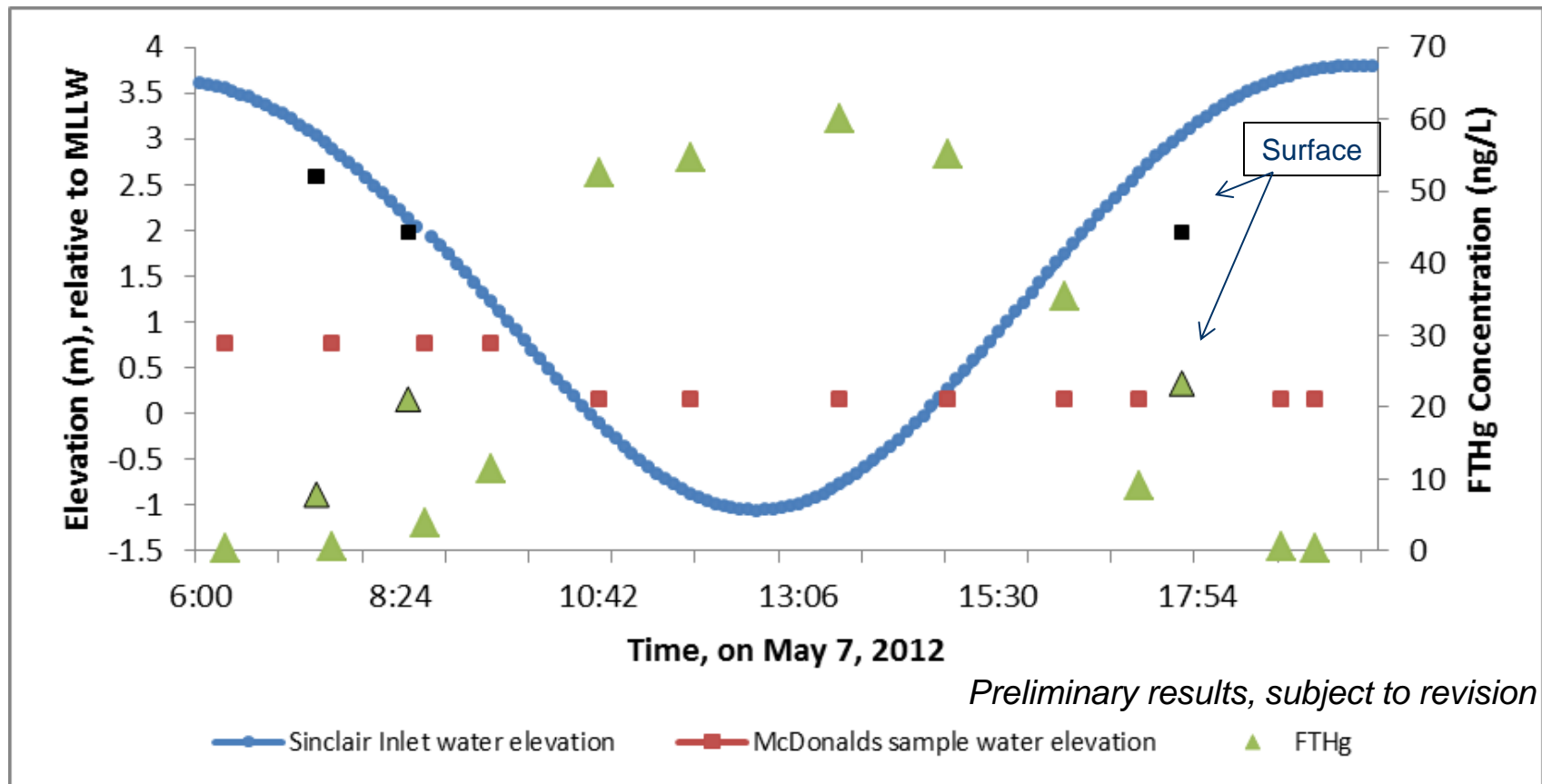


*Preliminary results, subject to revision*

# Spring Tide (May 7, 2012)

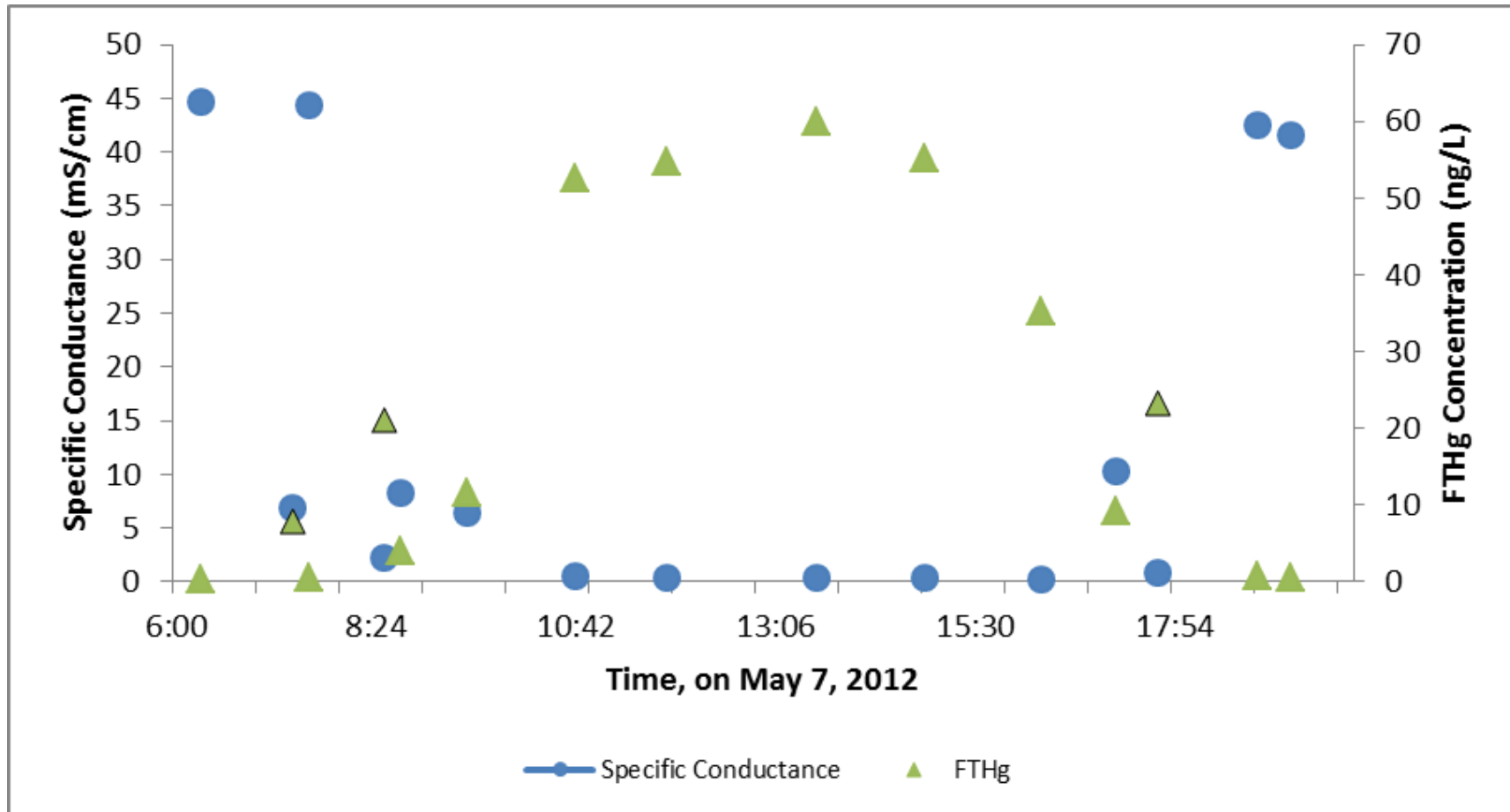
- FTHg Concentrations

- Increased when Sinclair Inlet water level dropped below vault water level (freshwater in vault)
- Higher FTHg in surface (vs. bottom) samples



# Spring Tide (May 7, 2012)

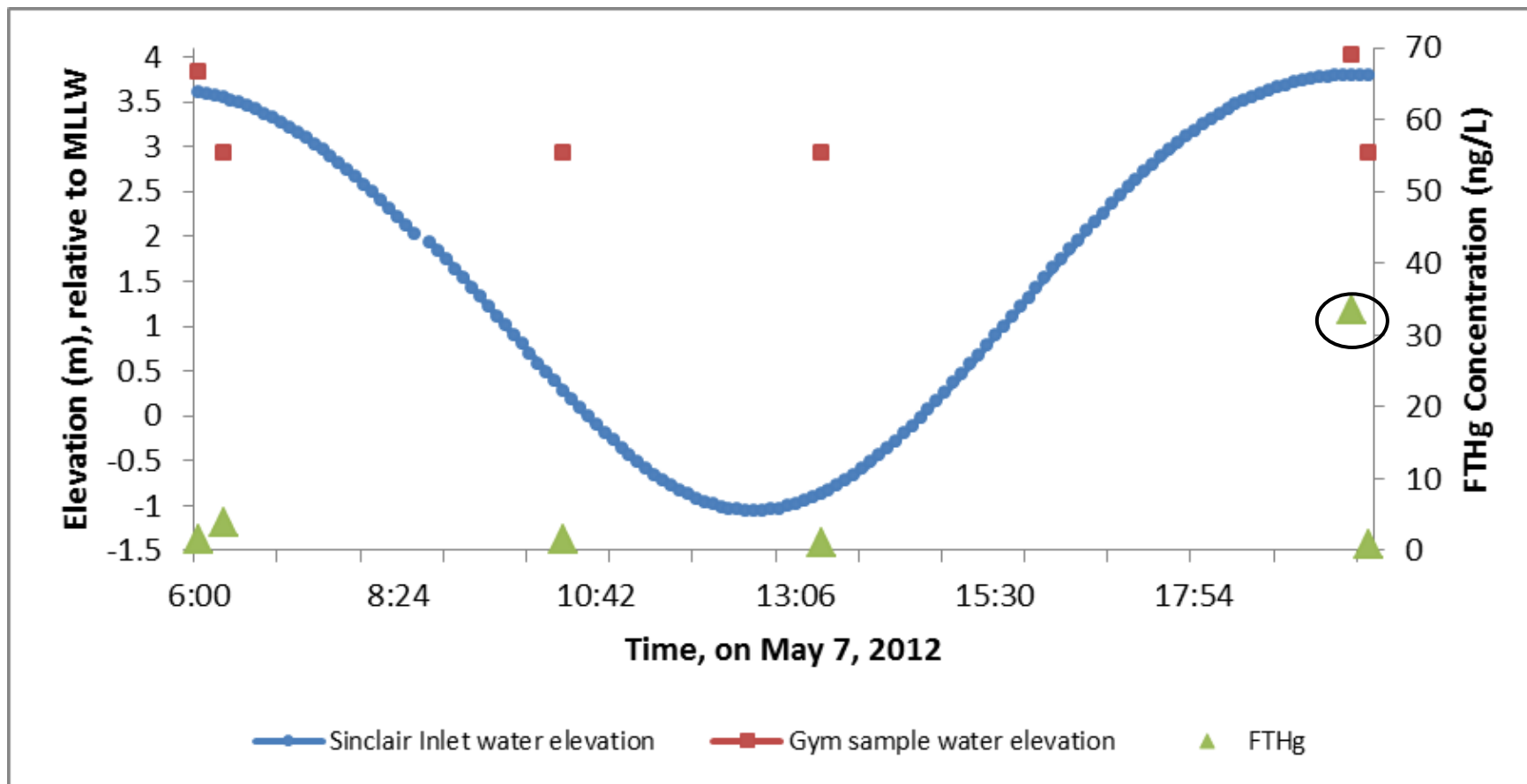
- FTHg concentrations high in freshwater, low in saltwater



*Preliminary results, subject to revision*

# Spring Tide (May 7, 2012)

- FTHg at Gym vault
  - Elevated FTHg in surface (freshwater) sample in flooding tide



*Preliminary results, subject to revision*

# Summary of Spring Tide study

- Spring tide conditions resulted in a flushing of PSNS015 to Sinclair Inlet
  - Flooding tide: Freshwater lens was pushed up the drain (and into contaminated soils)
  - High tide: Saltwater intrusion extended to gym
  - Ebbing tide: Draining of pipe due to hydraulic head
    - FTHg concentrations up to 60 ng/L (McDonalds freshwater)
- Very high FTHg (1140 ng/L) in saltwater in well OUBT 722 adjacent to seawall

4	06:25	06:25	06:25	06:25	06:26	06:26	06:26	06:26	06:27	06:27	06:27	06:27	06:28	06:28	06:28
6	04:21	09:23	15:43	22:32	05:14	10:36	16:31	23:11	06:09	12:00	17:27	23:52	07:06	13:33	18:33

Sampling window during neap tide,  
June 26-27, 2012

24-hour precipitation totals:

<0.25 mm      0.25 mm      <0.25 mm      <0.25 mm

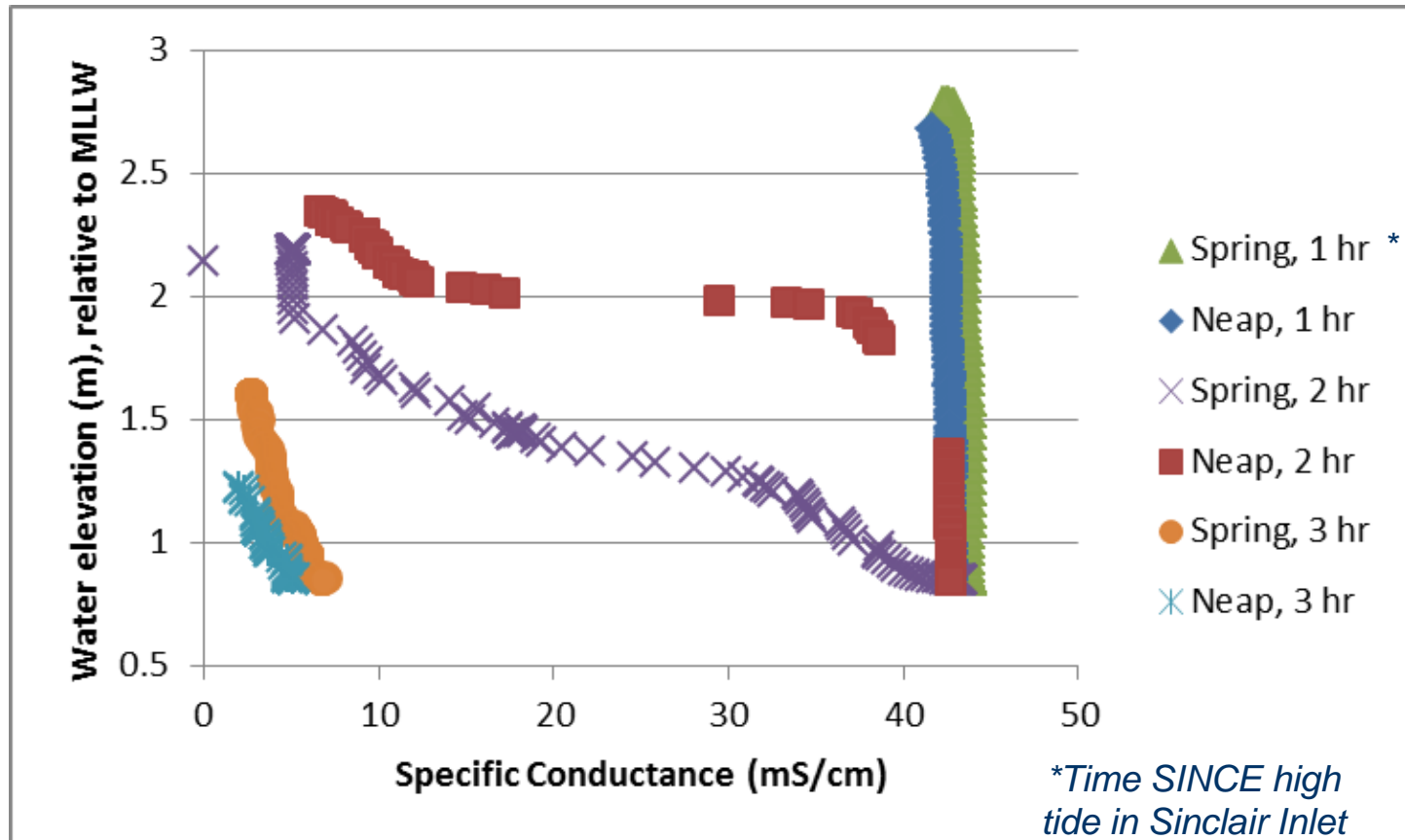
Timeline visualization of the 2019-2020 season. The top bar shows four segments: three labeled **<0.25 mm** and one labeled **0.25 mm**. Below this, a timeline from 00:00 to 21:00 shows precipitation events as vertical red lines. The background is color-coded by precipitation intensity: green for **<0.25 mm** and blue for **0.25 mm** or greater. Time markers are provided at 3-hour intervals.

**<0.25 mm**

# Neap Tide (June 26-27, 2012)

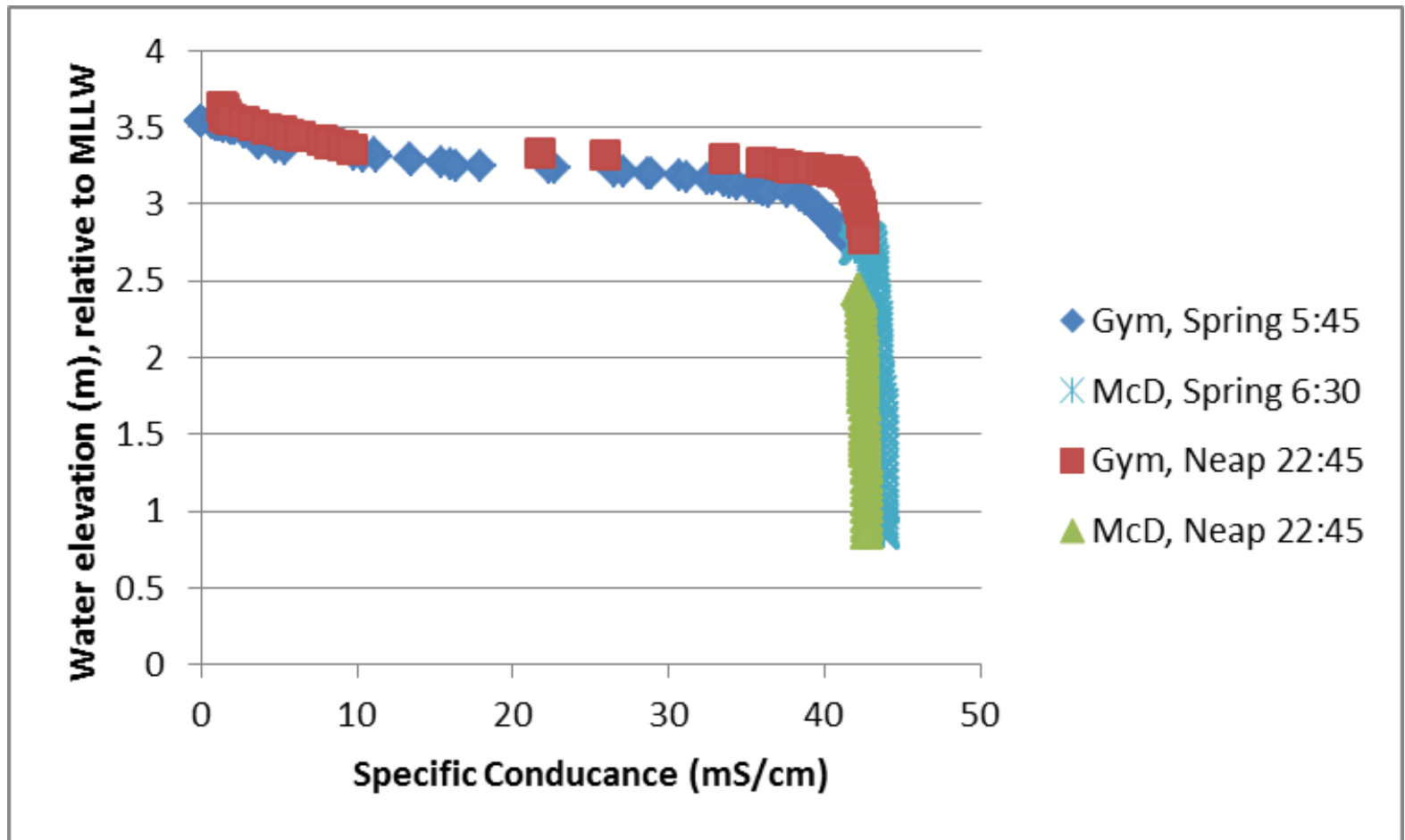
- CTDs in McDonalds vault (vs. Spring):
  - Sharper salt/fresh interface during ebbing tide
  - Similar curve, lower water levels

*Preliminary results,  
subject to revision*



# Neap Tide (June 26-27, 2012)

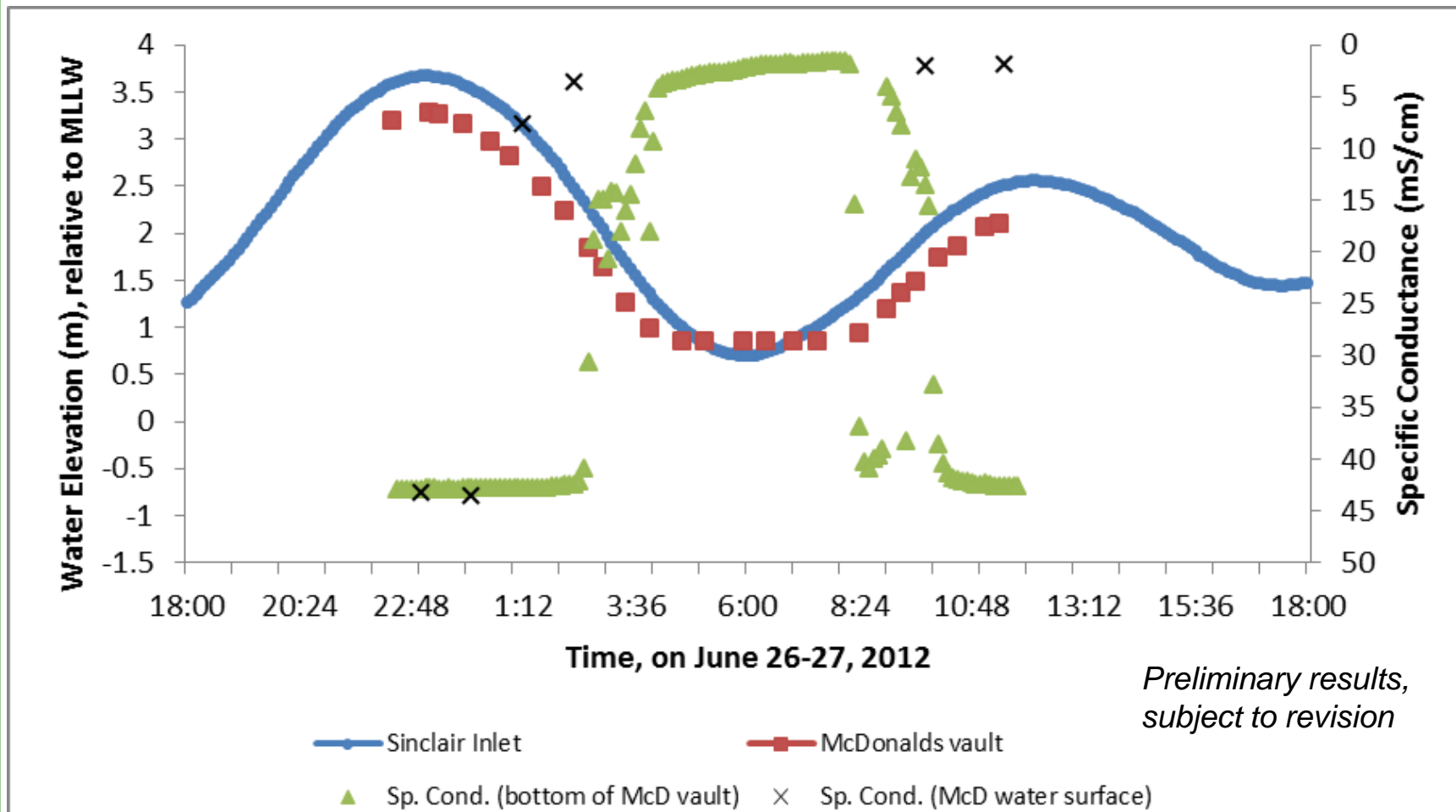
- Salt wedge extended to gym (same as Spring)



*Preliminary results, subject to revision*

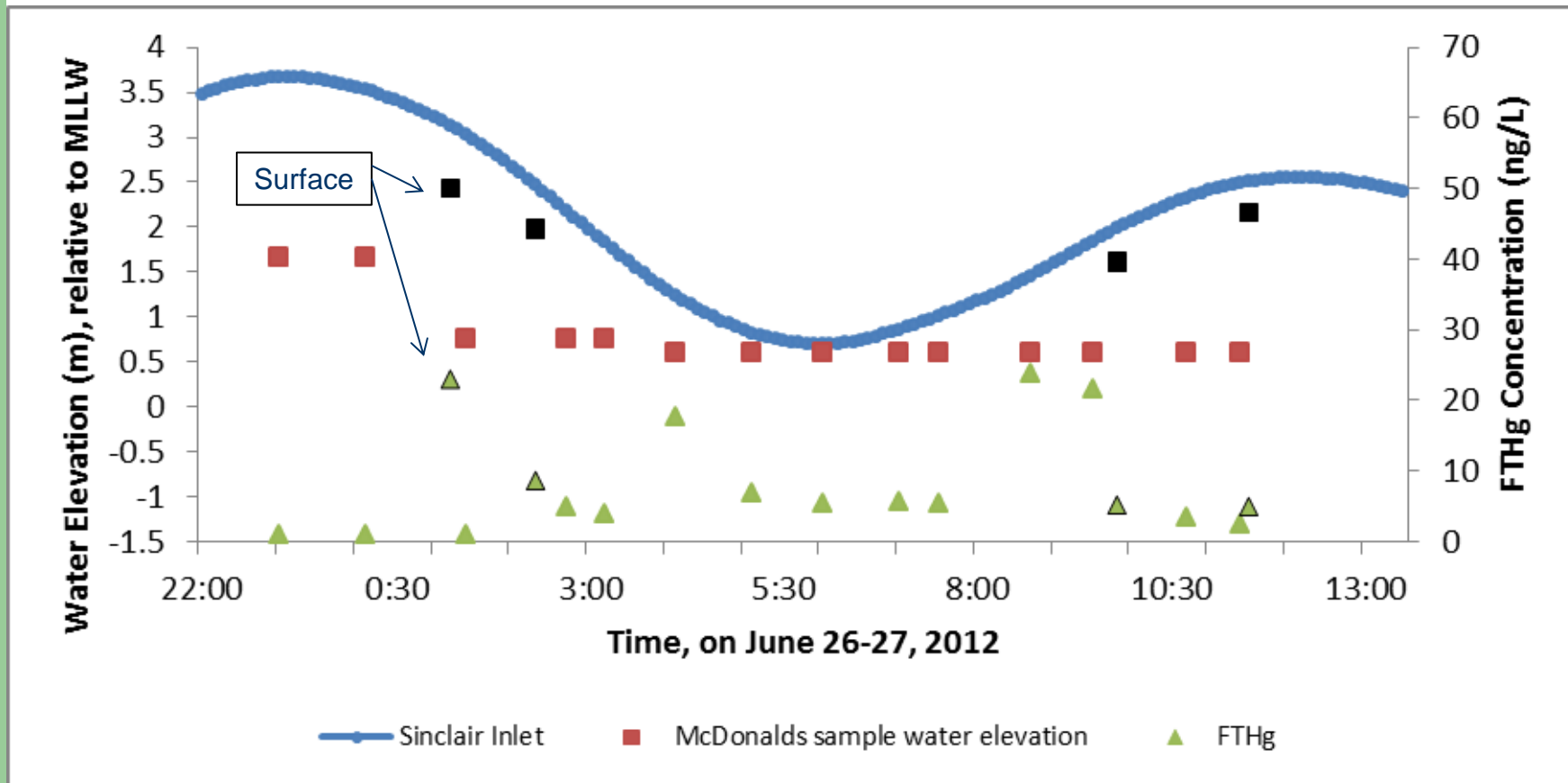
# Neap Tide (June 26-27, 2012)

- Water elevation – Water level in Sinclair Inlet never dropped below vault water level



# Neap Tide (June 26-27, 2012)

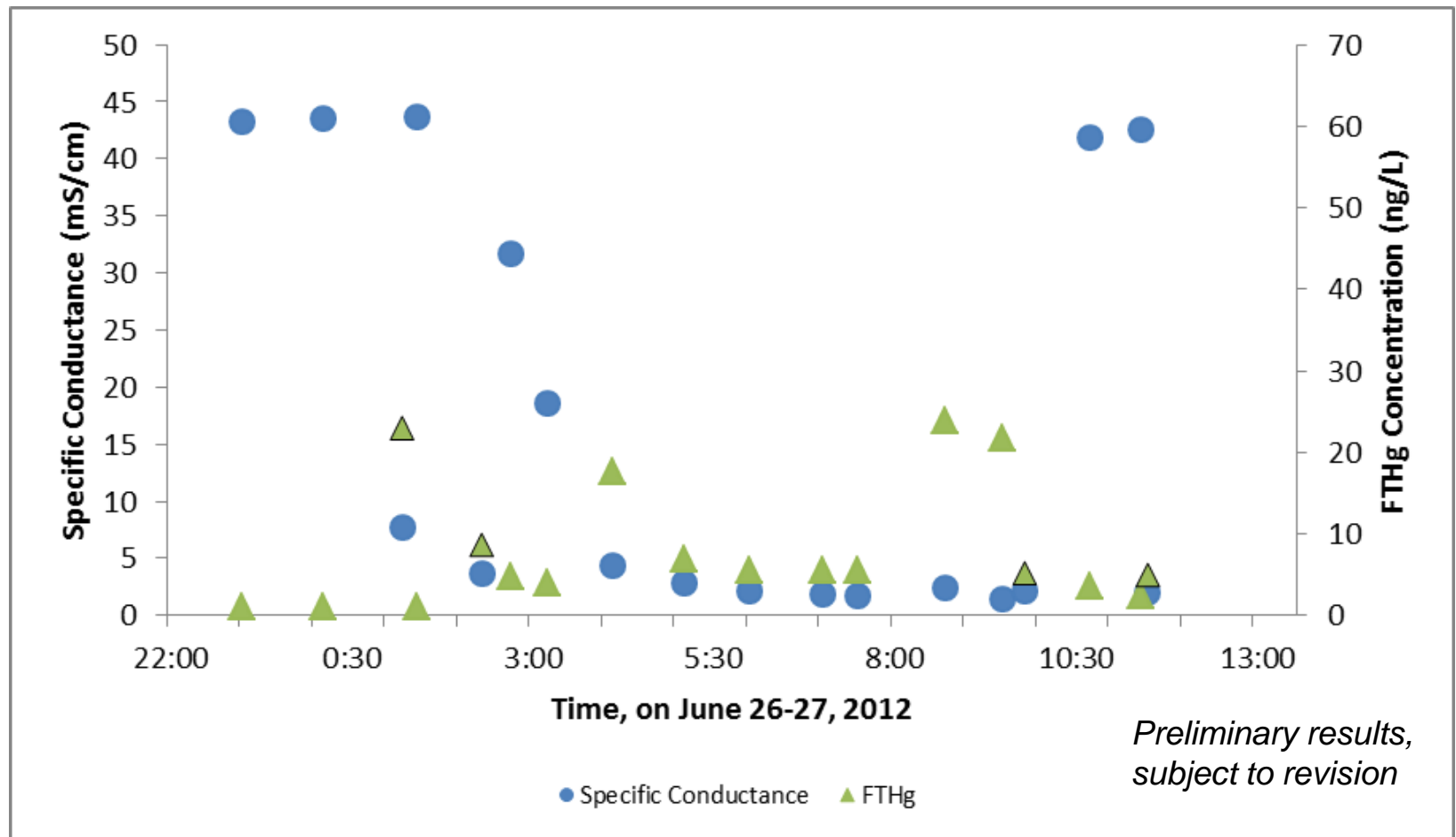
- FTHg concentrations
  - Less than 25 ng/L (vs. 60 ng/L during spring tide)



*Preliminary results, subject to revision*

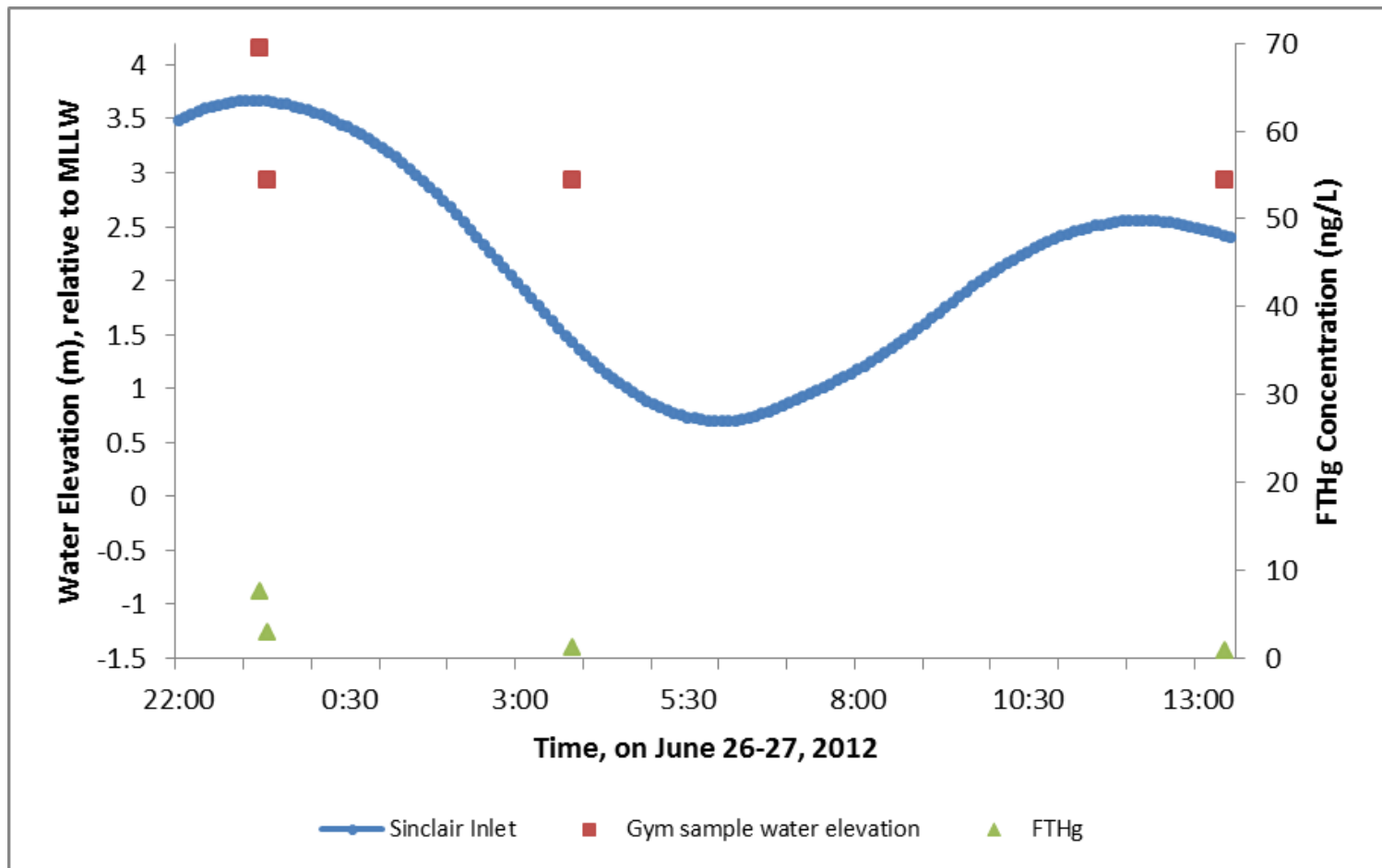
# Neap Tide (June 26-27, 2012)

- FTHg concentrations
  - No relationship with specific conductance



# Neap Tide (June 26-27, 2012)

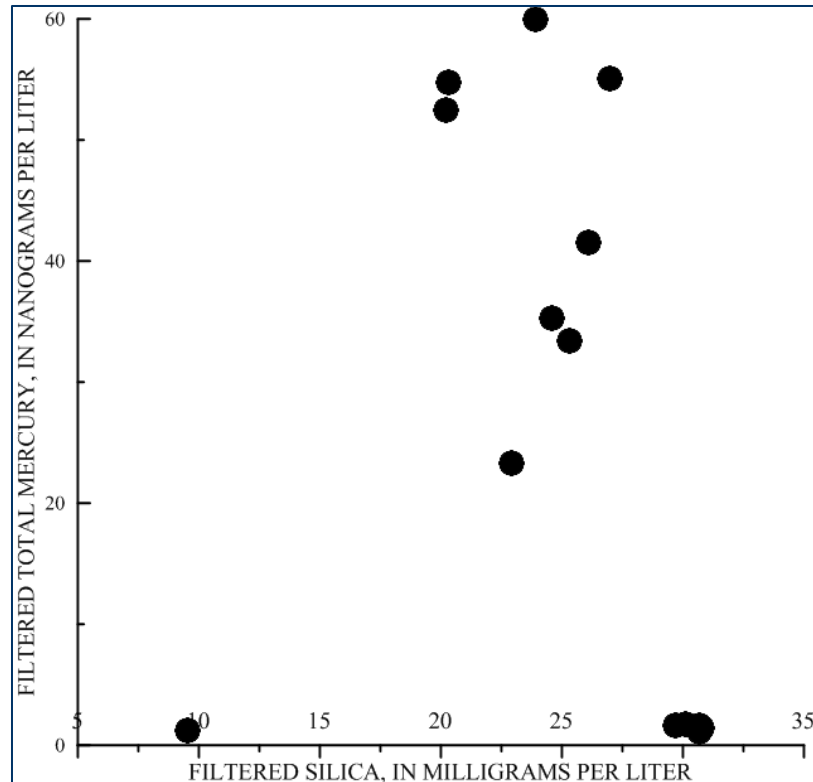
- Gym vault - Low FTHg concentrations



*Preliminary results, subject to revision*

# Continuing data analysis

- PTHg and TSS to analyze THg of solids
  - Preliminary analysis suggests similar trends as FTHg
- Major ions
  - Relationship to Hg



*Preliminary results, subject to revision*

# Summary to date

- In PSNS015 during high tide, saltwater can extend up to the gym
  - Freshwater lens sitting on top of saltwater
- No sources of FTHg identified upstream of McDonalds vaults
  - During ebbing tide, with minor precipitation, FTHg <10 ng/L in freshwater in 6 vaults from McDonalds to Commissary
- Spring tide conditions resulted in a flushing of PSNS015 to Sinclair Inlet
  - During ebbing tide:
    - Sinclair Inlet water level drops below McDonalds vault water level
    - Highest concentrations were in freshwater (FTHg ~ 60 ng/L) in the McDonalds vault
    - Also very high FTHg concentrations (1140 ng/L) in saltwater in well OUBT 722 adjacent to seawall
  - Hg in freshwater is not from overland flow

*Preliminary results,  
subject to revision*

# Summary to date

- Neap tide conditions do not result in PSNS015 flushing
  - Sinclair Inlet water level does not drop below McDonalds vault water level
  - Low FTHg concentrations (typically <10 ng/L, all <25 ng/L)
- Hypothesized mechanism:
  - During flooding tide:
    - Seawater extends to gym
    - Freshwater lens is pushed up the drain and into Former Site 2 contaminated soils
  - Ebbing tide:
    - Pipe drains due to hydraulic head, carrying extracted Hg to Sinclair Inlet

# Acknowledgements

- MIPR N6247312MPT0001
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